CLAIMS

Having described the preferred embodiments, the invention is now claimed to be:

1. A magnetic resonance imaging method comprising:

determining a magnitude shift of a main B_0 magnetic field responsive to energizing one or more shim coils **(60)** at selected shim currents;

energizing the one or more shim coils **(60)** at the selected shim currents; and

performing a correction during the energizing to correct for the determined magnitude shift of the main B_0 magnetic field.

2. The magnetic resonance imaging method as set forth in claim **1**, wherein the performing of a correction comprises:

adjusting a center frequency of radio frequency receiver and transmitter components **(44, 46)** to correspond to a magnetic resonance frequency at the B_0 magnetic field including the determined magnitude shift.

3. The magnetic resonance imaging method as set forth in claim **1**, wherein the performing of a correction comprises:

energizing a D.C. shim coil **(82)** at a D.C. shim current effective for canceling the determined magnitude shift of the main B_0 magnetic field.

4. The magnetic resonance imaging method as set forth in claim **1**, wherein the performing of a correction comprises:

energizing one or more gradient coils **(30)** to correct for one or more first order spherical harmonic terms of the determined magnitude shift of the main B_0 magnetic field.

5. The magnetic resonance imaging method as set forth in claim **1**, wherein the determining a magnitude shift comprises:

computing one or more Maxwell terms of the magnetic field produced by energizing the one or more shim coils **(60)** at selected shim currents; and

determining the magnitude shift of the main B_0 magnetic field based on the computed one or more Maxwell terms.

6. The magnetic resonance imaging method as set forth in claim **1**, wherein the determining of a magnitude shift comprises:

for each of the one or more shim coils **(60)**, determining one or more Maxwell term coefficients of the magnetic field produced by energizing that shim coil at the corresponding selected shim current;

for each of the one or more shim coils **(60)**, determining a magnitude shift contribution of that coil by (i) obtaining one or more Maxwell terms corresponding to the one or more Maxwell term coefficients of that coil by multiplying each Maxwell term coefficient of that coil by the current raised to a corresponding even power and (ii) summing the Maxwell terms.

7. The magnetic resonance imaging method as set forth in claim **6**, wherein the one or more shim coils **(60)** includes a plurality of shim coils, and the determining of a magnitude shift further comprises:

additively combining the magnitude shift contributions of the plurality of coils **(60)** to determine the magnitude shift of the main B_0 magnetic field.

8. The magnetic resonance imaging method as set forth in claim **6**, wherein the determining of one or more Maxwell term coefficients comprises one of:

computing the Maxwell term coefficients based on a geometry of the coil, and

fitting a magnetic field produced by energizing the shim coil at a reference current to an expression including a sum of one or more Maxwell terms parameterized by the corresponding one or more Maxwell term coefficients, said Maxwell term coefficients being stored and subsequently recalled during the determining of a magnitude shift contribution of that coil.

9. The magnetic resonance imaging method as set forth in claim **1**, wherein the one or more shim coils **(60)** includes a plurality of shim coils, and the determining a magnitude shift comprises:

for each coil, determining a functional relationship between shim current and a shift contribution of that coil;

inputting the selected shim current into the functional relationship to determine a shift contribution corresponding to the selected shim current; and

combining the shift contributions corresponding to the selected shim currents of the plurality of coils to determine the magnitude shift.

10. The magnetic resonance imaging method as set forth in claim **9**, wherein the combining of the shift contributions comprises:

determining the shift contribution for each shim coil in a vector form;

additively combining the shift contribution vectors for each shim coil; and

determining the magnitude of the vector shift contributions corresponding to the selected shim currents of the plurality of coils **(60)**.

11. The magnetic resonance imaging method as set forth in claim **1**, further comprising:

selecting the selected shim currents by optimizing a figure of merit including the shim currents of the shim coils **(60)** and a shim current of a D.C. shim coil **(82)**, wherein the performing of the correction includes energizing the D.C. shim coil **(82)** at an optimized shim current obtained by the optimizing of the figure of merit.

12. The magnetic resonance imaging method as set forth in claim **1**, further comprising:

dynamically selecting shim currents to dynamically shim the main B_0 magnetic field during magnetic resonance imaging, the determining of a magnitude shift, energizing, and performing of a correction being repeated for each selection of shim currents.

13. The magnetic resonance imaging method as set forth in claim **1**, further comprising:

performing multi-slice magnetic resonance imaging of an imaging subject; and

for each slice, selecting shim currents of the one or more shim coils **(60)** to dynamically shim the main B_0 magnetic field for that slice, the determining of a magnitude shift, energizing, and performing of a correction being performed for imaging of that slice.

14. The magnetic resonance imaging method as set forth in claim **1**, further comprising:

dividing a region to be imaged into a plurality of imaging regions;

for each imaging region, determining selected shim currents effective for shimming the main B_0 magnetic field in that imaging region, the determining of the magnitude shift responsive to energizing one or more shim coils **(60)** at selected shim currents being separately performed for each imaging region for the selected shim currents effective for shimming the main B_0 magnetic field in that imaging region; and

acquiring imaging data for each imaging region, wherein:

(i) the energizing is performed as part of the imaging and uses the selected shim currents effective for shimming the main B_0 magnetic field in that imaging region being imaged, and

(ii) the performing of a correction is performed with respect to the magnitude shift determined for that region being imaged.

15. A magnetic resonance imaging apparatus comprising:

a means **(20)** for generating a main B_0 magnetic field;

one or more shim coils **(60)** for shimming the main B_0 magnetic field;

a means **(70)** for determining a magnitude shift of the main B_0 magnetic field responsive to energizing the one or more shim coils **(60)** at selected shim currents;

a means **(64)** for energizing the one or more shim coils **(60)** at the selected shim currents; and

a means **(44, 80, 82)** for performing a correction during the energizing to correct for determined magnitude shift of the main B_0 magnetic field.

16. The magnetic resonance imaging apparatus as set forth in claim **15**, wherein the means **(70)** for determining the magnitude shift includes a processor which performs a process including:

determining one or more Maxwell terms coefficients for each shim coil;

computing a magnitude shift of the main B_0 magnetic field produced by each coil based on a shim coil function having functional parameters

including the one or more Maxwell term coefficients for that coil and the selected shim current for that coil; and

combining the magnitude shift of the main B_0 magnetic field produced by each coil.

17. The magnetic resonance imaging apparatus as set forth in claim **15**, wherein the correction performing means **(44, 80, 82)** includes at least one of:

a means **(80)** for activating a zero order shim coil **(82)** to adjust a magnitude of the main B_0 magnetic field; and

a means **(44)** for shifting a resonance excitation frequency.

18. A magnetic resonance imaging scanner comprising:

a main magnet **(20)** generating a main B_0 magnetic field;

one or more shim coils **(60)** selectively shimming the main B_0 magnetic field at selected shim currents; and

a processor **(70)** executing a process including determining a magnitude shift of the main B_0 magnetic field responsive to the selective shimming.

19. The magnetic resonance imaging scanner as set forth in claim **18**, further comprising:

a zero order shim coil **(82)** selectively energized to counteract the determined magnitude shift of the main B_0 magnetic field responsive to the selective shimming.

20. The magnetic resonance imaging scanner as set forth in claim **18**, further comprising:

a tunable radio frequency transceiver **(44, 46)** generating a radio frequency signal and detecting magnetic resonance signals produced responsive to the generated radio frequency signal;

wherein the process executed by the processor **(70)** further includes computing a magnetic resonance frequency corresponding to the main B_0 magnetic field including the determined magnitude shift, the tunable radio frequency transceiver **(44, 46)** being tuned to the computed magnetic resonance frequency.